INCREASE OF IRON CONTENT IN RELATION TO SPECIFIC GRAVITY AND DEGREE OF WEATHERING OF LATERITE SOIL IN MANGGURUH AREA, SOUTH KALIMANTAN

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ABSTRACT

Mangguruh area located in Sebuku Island, South Kalimantan Province belongs to one of the lateritic mining land areas in Indonesia. The soil is derived from ultramafic rock. The purpose of this study is to compare the more appropriate properties to be used as a consideration of the classification of soil laterite characteristics. The study was conducted by sampling at 1 drill hole with 13 m depth. Undisturbed soil samples were tested by physical tests, while core drill samples were analyzed by X-Ray Fluorescence to determine Fe content. The result of the test analysis of soil consistency limits and gradation of grain yields the physical and mechanical parameters of the soil with various numbers. The characteristic that differentiates laterite soil from other soils is the laterite zones indicating the degree of weathering of the laterite soil. Based on the classification of USCS, it is known that red limonite soils have diverse soil types, while yellow limonite and saprolite consist of silt with high plasticity (MH) type. Changes in Fe content in the limonite zone and saprolite zone are similar to the changes that occur in the specific gravity values. It is known that the specific gravity of the laterite soil may be considered as a classification parameter in order to further understand the laterite soil characteristics associated with the degree of weathering.

Keywords: laterite soil, iron content, specific gravity, degree of weathering

1. INTRODUCTION

Background

Mangguruh area that is located on Sebuku Island, South Kalimantan Province is an area that belongs to one of the mining areas of laterite soil in Indonesia. The laterite soil is derived from ultramafic rocks, having a distinctive weathering profile with different degrees of weathering. Genesis and parent material factors, climate, vegetation, topography, weathering period, degrees of weathering, and soil depth in the profile have influence on the geotechnical properties and laterite soil characteristics in the field (Gidigasu, 1976). Site characterization are important element in geotechnical engineering projects. Types of soils in laterite is determined by different degree of weathering, so it is important to describe and classify them in terms that exude their characteristics clearly.

Purpose of Paper

A lot of studies have been done to find out about the engineering properties characterization of different laterite soils types as the determination of soil conditions is the most important in civil engineering works. Pasticity and grain size data for laterite soils are extremely varied. This paper discusses the comparises of geotechnical properties which are specific gravity, grain size distribution and plasticity in order to know which one is reflects the degree of weathering on the laterite soils.

2. LITERATURE REVIEW

The laterite soil deposits in the research area are the result of weathering of ultramafic rocks, such as Harzburgite, Dunit, Serpentinite, Gabbro, and Basalt which have been serpentinized. This ultramafic rock touches tectonically with the units around it. This formation is the oldest rock.

In a general engineering definition, soil is defined as a material consisting of aggregates of solid minerals which are not saturated (chemically bonded) to each other and of decayed organic matter (solid particles) accompanied by liquid and gases that fill the empty spaces between the solid particles. Grains of minerals that form the solid part of the soil, are the result of weathering of rocks. The soil is influenced by the parent rock, climate, topography, organism, and time. The soil can be divided into two major groups, derived from weathering (physics and chemistry) and derived from organic matter.

The soil consists of three phases containing water, air and mineral and organic materials and living organisms, which, due to the influence of various environmental factors on the surface of the earth and time, form a variety of changes that have distinctive morphological features. (Das, 1995). If the fine-grained soil contains clay minerals, then the soil can be kneaded (remolded) without causing cracks. This cohesive nature is due to absorbed water around the surface of the clay particles. Therefore, on the ground water, soils can be separated into four basic states: solid, semi-solid, plastic, and liquid.

According to Alexander and Cady (1962), laterite is a material rich in aluminum oxide, iron oxide or both. Laterite has almost no silicates, but can have high quartz and kaolinite content. Laterite also has the possibility to harden under wetting and drying conditions, and it is a feature of laterite. Gleeson, et. al (2003), divide laterite nickel profile at least divided into three parts, namely the bedrock zone, saprolite zone and limonite zone.

Many genetic hypotheses of the laterite have similarities that are weathering processes involving the washing of silica, the formation of sesquioxides, and precipitation of the oxide when the rock is weathered. Genesis and parent material factors, climate, vegetation, topography, weathering period, degrees of weathering, and soil depth) in the profile have an influence on the geotechnical properties and laterite soil characteristics in the field (Gidigasu, 1976). Mohr and Van Baren in Tuncer, 1976 states that the same type of rock can produce weathering products whose composition is very different if there are topographic differences and drainage process deficits.

3. METHODOLOGY

Undisturbed Sample (UDS) samples were obtained to collect soil samples with the original condition when taken and could be used for the purposes of laboratory testing. UDS sampling using Shelby Tube made of steel done by drilling. Soil sampling is done at 1 point with depth up to 13 m. The core samples for geochemical analysis were performed by drilling using barrel diameter NQ of 11.06 cm. The collected soil was subjected to laboratory tests in order to determine its basic properties included Specific Gravity, Atterberg Limits, and Particles Size Analysis. Iron content of the core drill samples were prepared with specific weights and the laboratory test was performed in the form of X-Ray Fluorescene test which yielded the amount of iron content in percent (%) at the specified depth.

4. RESULT AND DISCUSSION

Laterite Zones in Research Area

In the borehole, there is a red limonite zone up to a depth of 3.75 m, a yellow limonite zone up to a depth of 9.25 m, a saprolite zone up to a depth of 11.5 m and followed by the bedrock zone. Based on laboratory tests, the soil properties are dominated by cohesive soils in the yellow limonite zone and the saprolite zone. Zones are classified color descriptions, weathering levels, magnetism strength, and changes in mobile and immobile elements.

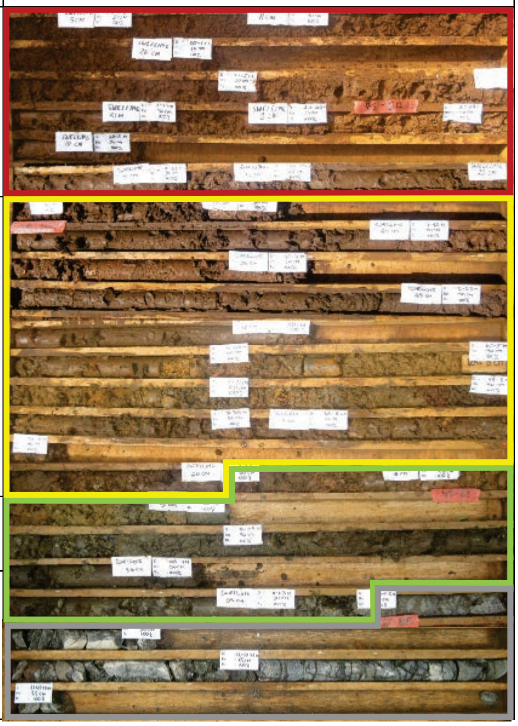
Depth (m)		Zone	Photo
From	*To*		*Top* *Bottom*
0.00	3.75	Red Limonite (RLIM)	
3.75	9.25	Yellow Limonite (YLIM)	
9.25	11.30	Saprolite (SAP)	
11.30	13.00	Bed Rock (BR)	

Table 1 : Divided Laterite Zones

Fe Content Elements

Iron mineral accumulation can be found in the limonite zone. The presence of these elements indicates that Fe is an immobile element that can survive in the limonite zone. Such intensive oxidation makes Fe in the red limonite zone adjacent to the surface in some places to form the iron gravel resulting from the accumulation Fe elements. The limonite zone is a zone where the leaching process runs intensively making the mobile elements have a very small abundance in this zone and the high abudance of immobile elements. Changes in weathering intensity occur in the saprolite zone which causes a minimum amount of Fe element so Fe is used as a zone division parameter on laterite based on weathering level and corfirmed by the field description.

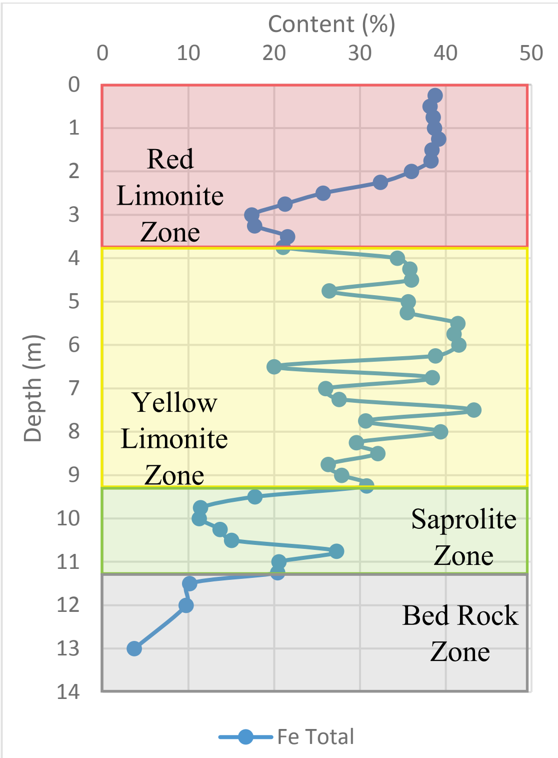


Figure 1 Curve of Iron Content

Soil Properties

Soil tests were perform based on American Standard Testing Materials (ASTM). The detailed results were summarized in Table 2 below. Table 2 indicated that the result of specific gravity ranged from 3,16-3,25 at red limonite zone then increase in yellow limonite zone become 3,2 - 3,85 and decrease at saprolite zone which is 2, 8. When compared with the amount of iron in each zone, the specific gravity in the red limonite zone follows the amount of iron that begins to decrease into the yellow limonite zone. There is a re-increase in the yellow limonite zone which causes the high value of specific gravity. The specific gravity value is below 3 in the saprolite zone as the decrease in Fe count is due to changes in weathering intensity in the saprolite zone.

Particle size distribution test was conducted to obtain the quantity of particle size distribution. Soil gradation is the number and distribution of grain size that can be obtained from the graph of filter analysis and hydrometer analysis, so that the information obtained about good gradation. This particle size analysis is used for soil classification together with Atterberg test results to determine the soil engineering properties. Based on these data, the highest gravel and sand content were 6.00% and 47.90% respectively at the depth of 2.00 - 2.70 m in the red limonite zone. The highest clay content of borehole is 43.50% at a depth of 9.00 - 9.50 m in the saprolite zone. The percentage of sand opposite to silt is the high percentage of sand in the red limonite zone, decreasing in the yellow limonite zone and increasing in the saprolite zone. The distribution of clay grain size increased and decreased in the yellow limonite zone.

Table 2 : Index properties of studied soils

Parameters		Depth (m)							
		0.30 – 1.00	1.00 – 1.70	2.00 – 2.70	2.70 – 3.40	4.00 – 4.70	4.70 – 5.40	6.00 – 6.70	9.00 – 9.50
Lithotype		Rlim	Rlim	Rlim	Rlim	Ylim	Ylim	Ylim	Sap
Specific Gravity		3.22	3.25	3.22	3.16	3.2	3.57	3.85	2.58
Particle Size Distribution (%)	Gravel	0.00	0.00	6.00	3.70	0.00	0.00	0.00	0.00
	Sand	21.8	46.8	47.9	47.8	24.6	31.9	22.8	32.7
	Silt	51.9	26.8	21.0	20.0	36.4	45.7	50.1	23.8
	Clay	26.3	26.4	25.1	28.5	39.0	22.40	27.10	43.50
Consistency Limits (%)	Liquid Limit	52.8	44.7	44.1	44.3	72.9	69.1	69.1	85.1
	Plastic Limit	33.7	31.6	30.1	30.7	46.3	42.7	41.8	68.7
	Plasticity Index	19.1	13.06	13.94	13.6	26.56	26.46	27.31	16.44
Classifications (USCS)		MH	ML	SM	SM	MH	MH	MH	MH

The soil consistency limits test is performed to determine the lowest water content limits. From the Atterberg Limit test results, data obtained in the form of liquid limit, plastic limit, and plasticity index. Based on the table above, the liquid limit value is 44.07 - 52.77% in the red limonite zone, 69.12 - 72, 86% in the yellow limonite zone and 85.14% in the saprolite zone, the plastic limit value in the zone Red limonite was 30.13 - 33.7%, 26.46 - 27.31% in the yellow limonite zone and 68.7% in the saprolite zone. Plasticity index value in red limonite zone 13.06 - 19.06%, in yellow limonite zone 26.46 - 27.31% and in saprolite zone of 16.44%. From the plotting data of the plasticity index and the liquid limit, soil samples are generally in the low plastisity (ML) and high plasticity (MH). The relationship between the various phases of soil consistency is directly proportional and there is a change in the values as the depth increases and approaches the fresh rock zone.

Based on the analysis of the particle size and soil plasticity properties and classified according to USCS, the soil is classified in Silt High Plasticity (MH) at red limonite zone 0.30 - 1.00 m depth, yellow limonite zone and depth saprolite zone 4.00 - 9.50 m; Silt Low Plasticity (ML) in red limonite zone depth 1.00 - 1.70 m; and Sandy Silt (SM) at red limonite zone depth of 1.00 - 3.40 m. Variations are present in the red limonite zone and there is a similarity of soil type in the yellow limonite and saprolite zones so that it can not show that it is related to the level of weathering.

5. CONCLUSION

Iron levels increase with increasing levels of weathering. Plasticity and gradation data on soil did not show different degrees of weathering so it is quite difficult to use plasticity and gradation data as classification parameters of laterite soil characteristics. While the specific gravity may be used as a parameter that reflects the degree of weathering on the laterite soil since its associated with changes in the amount of iron. This is evidenced by the definition of the specific gravity in which the specific gravity is the average weight of the specific gravity of minerals that make up the soil. In addition to weathering, the number of heavy minerals will continue to increase then the specific gravity will increase as the weathering process.

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